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OUTER SPACE
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Thirtieth session
Agenda item 7

USE OF NUCLEAR POWER SOURCES IN OUTER SPACE

Safety principles for nuclear power sources in space revisited

Working paper submitted by the United Kingdom of Great Britain and Northern Ireland

The following paper attempts to summarize the achievements to date in formulating the principles relating to the use of nuclear power sources (NPS) in outer space. The working paper also suggests a number of ways in which the principles could be further improved.

Introduction

The event which led to the formulation of principles relevant to the use of nuclear power sources (NPS) in outer space by the Committee on the Peaceful Uses of Outer Space was the arrival in northern Canada of debris from Cosmos 954 on 24 January 1978. This event highlighted the risk to all countries from NPS in space, not just to the few countries actively involved in launching these devices. That it took over a decade to reach agreement on a set of principles reflects the technical nature of the subject covered by the principles as well as the initial diversity of views among the many countries concerned about the hazards from NPS in space. That agreement was reached in 1992 and reflects the determination of those countries to reach an international consensus.

Yet the adoption of the principles was accompanied by the recognition that the process of revision should begin immediately. The form of some of the principles reflected the state of space NPS technology in the 1980s, already being overtaken by new developments. Ideally, principles should be

technology-independent so that the requirement for change is infrequent. For example, a kilogram of plutonium-238 is more toxic than a kilogram of plutonium-239 by a factor of around 250 (virtually identical to the ratio of their half-lives) but the principles allow plutonium-238 fuelled thermionic generators (RTGs) but not plutonium-239 fuelled reactors: the assumption that reactor containment standards will always be worse than those of RTGs by a factor of 250 is only of short-term validity. The principles do not deal adequately with nuclear propulsion which is now under serious development and there is no adequate definition of a "safe orbit" because, to date, the problem of space debris has not been properly addressed.

The tremendous effort put into the development of the principles adopted in 1992 was an essential foundation to the establishment of an international safety regime for the use of NPS in space. It is now proposed to build on that structure taking account of recent technical advances and parallel developments in related safety fields.

Terrestrial experience

Experience with land-based reactors seems to provide some useful pointers to the best way to proceed. Terrestrial radiological safety principles have become highly developed under the aegis of the International Commission for Radiological Protection (ICRP). This has been recognized in the existing "principles" though with some departure from the ICRP philosophy. The latest ICRP-60 recommendations are particularly helpful through the extension of the earlier versions to accidents not involving acute deaths.

Terrestrial reactor safety principles have developed independently in many countries. Advances in probabilistic risk assessment (see, for example, the proceedings of the International Atomic Energy Agency (IAEA) conference at Vienna from 3 to 7 June 1991, and International Nuclear Safety Group INSAG-6, 1992) have led to substantial convergence of national views, and the IAEA General Conference in September 1991 recommended that the Director General prepare an outline of a nuclear safety convention. The groundwork for this had already been laid by the Agency's standing groups, particularly the International Nuclear Safety Advisory Group (see INSAG-3, 1988). An IAEA publication on safety fundamentals is imminent, defining safety objectives and their impact not only on technical aspects of design, construction, operation and decommissioning, but also on management and the influence of human factors.

The difference between safety considerations for land-based and space NPS arises mainly from the large difference in perceived transnational risk. Land-based systems hazard mainly the country of origin, with sites near to national borders sometimes dealt with under bilateral agreements. Systems destined for operation in outer space give rise to some risk in the country of origin (probably the majority of the total risk) but the perceived risk is to all the countries which could be subject to impact on re-entry to the atmosphere, particularly under accident (i.e., uncontrolled) conditions. However, this difference is a matter of degree rather than of principle. The safety principles developed for land-based systems should be applicable in

space systems, a point noted in the preamble to INSAG-3. The principles for protecting people should be independent of their nationality.

A starting-point

There are a number of themes involved in establishing a safety regime which emerge clearly from the ICRP and IAEA publications:

- (i) Nuclear activities should only be undertaken if there is a net positive benefit, i.e., the benefits outweigh the detriments. Examples of activities which probably fail this test are the wearing of radioactive jewellery; exploring caves with high natural radon levels; atmospheric weapon tests; and satellite missions in Earth orbit which can obtain sufficient power from solar arrays of manageable size;
- (ii) The maximum risk arising should be limited to an acceptable level. In practice, different risk levels are commonly used for workers and the general public, in recognition that the worker gains more benefit than the rest of society; and for accidents involving a risk to a group of people rather than single isolated individuals, in recognition that society finds the death of a coherent group (family, football team, plant operators, tourist party, village) to be more traumatic and less acceptable than the same number of deaths scattered among unrelated groups. As well as limiting individuals and societal risks, consideration of damage to the natural and built environment is also required;
- (iii) Nuclear risks should be as low as reasonably achievable taking into account social and economic factors. This is the ALARA principle of ICRP which has its counterpart in reactor safety. Some risks are easy to guard against and can be effectively eliminated at reasonable cost, while others are technically difficult or economically expensive to reduce much below the maximum risk limit. The cost of reducing risks should be optimized against the benefit gained. ICRP has introduced the concept of dose constraints at levels below the dose limits to assist in the process of optimization, with the constraints set according to the local situation;
- (iv) Those carrying out nuclear activities should adopt a safety culture, that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear safety issues receive the attention warranted by their significance (INSAG-4, 1991). The safety culture has two general components: the safety-related framework within an organization and the commitment of management to its role, and the attitude of individuals at all levels in responding to this framework.

Although ICRP has not adopted a fully risk-based approach to radiological protection and IAEA is at a formative stage in developing an internationally accepted reactor safety regime, it is proposed that the way forward for the Committee on the Peaceful Uses of Outer Space in revising the "principles" should be a combined risk limitation/safety culture philosophy applied only to the transnational risk (recognizing that considerations of sovereignty preclude the Committee from monitoring national regulations) making maximum use of the ICRP and IAEA groundwork.

Tolerable and acceptable risks

A number of studies have analysed the acceptability of risk and identified factors involved, generally using fatal risks as a measure of hazard. Higher levels of risk are acceptable for those entered into voluntarily than for those imposed by others. Higher levels of risk are acceptable by those who benefit directly from the activity causing the risk. It can thus be expected that the acceptable level of transnational risk from NPS in outer space, an involuntary risk from an activity of only indirect benefit, will be at the lower end of the spectrum of acceptable risks.

Workers in an industry have some understanding of the risks they run and some choices in the matter. The maximum level of fatal risk in high risk groups within relatively risky industries in the United Kingdom is about 1 in 1,000 per year. This level of risk is only exceeded by deep-sea fishermen (1 in 750) and by workers in oil and gas extraction (1 in 990). The average radiation worker receives around 1 mSv per year, corresponding to an annual risk of 1 in 20,000, half the level of risk for the construction industry, while the average fatal risk for all manufacturing industry is 1 in 50,000, the safest occupations having risks of less than 1 in 100,000.

For the general public the risk of death by road accident, which may be considered largely voluntary, is 1 in 10,000 in the United Kingdom, and for all accidents 1 in 4,000. The risk corresponding to the ICRP public dose limit of 1 mSv per year is 1 in 20,000. The risk from a gas explosion at home (involuntary) is 1 in a million and from lightning 1 in 10 million.

Two risk levels can be conveniently identified from this type of analysis. First, there is the maximum tolerable fatal individual risk, above which risks are unacceptable. For involuntary risks to the general United Kingdom public this seems to be about 1 in 10,000 per year, about the same as for traffic accidents or a little lower than the risk from other accidents. Secondly, there is the generally acceptable individual risk which is normally ignored. This seems to be about 1 in a million for involuntary public risks; below this level of risk there seems to be no significant degree of concern.

Between these two levels (10^{-4} to 10^{-6} per year) the individual risk is generally acceptable, but reductions which can be achieved at acceptable social and economic cost are expected to be implemented. Higher standards of safety seem to be needed where the risk is to a coherent group of people rather than an individual. Terrestrial reactor safety studies suggest that

the maximum tolerable individual risk should be divided by the number (N) of fatalities, giving a maximum societal risk of $1/N \times 10^{-4}$. However, if the risk is spread out among a large population (as for world-wide atmospheric dispersion of radionuclides), the individual limit seems to be appropriate.

Protecting the natural and built environment is a more subjective process. In the context of land-based nuclear reactors, the main consideration seems to relate to the choice of site in relation to thermal pollution, visual intrusion and important habitats of natural species, particularly the human species. In space the environmental considerations are different and less well developed. There is a generally accepted view that contamination of Earth orbits should be avoided, although accumulating used space reactors in high Earth orbit has been considered acceptable. Certainly the interference with orbiting and some ground-based scientific experiments from space reactors with a high radiation field has attracted much adverse comment. Atmospheric dispersion on re-entry can give rise to a substantial global collective dose and the cost of this should be justified in comparison with the cost of alternative options, the benefits from the mission and the accumulated global hazard. Dispersion on impact is generally a less onerous event, often capable of mitigation using established decontamination technologies.

It must be emphasized that setting risk limits is a very subjective process. An individual indulging in five hours of solo rock climbing every weekend accepts voluntarily a fatal risk of 1 in 100. Pedestrian deaths in traffic accidents, an involuntary risk with no direct benefit to the risk taker, is around 1 in 30,000, well above the 1 in a million generally acceptable individual risk suggested above. It is necessary to take a rather broad view of tolerability and acceptability to identify corresponding risk value.

Space debris and nuclear safe orbits

One of the advantages of a probabilistic approach to the safety of NPS in outer space is that it extends naturally to considerations of space debris and the definition of safe orbits. Once the tolerable and acceptable risk levels have been defined, it is then purely a question as to whether any particular orbit satisfies these risk criteria, given the hazard from space debris. Similarly, the acceptability of additional debris is a technical question depending on the risk it creates through its impact on satellites. In the longer term, removal of radioactive material from Earth and Earth orbit is likely to be the best solution.

With principle 3 redrafted to use a probabilistic risk assessment, changes in the space debris environment can be readily taken into account.

Safety culture

The major accidents at Three Mile Island and at Chernobyl emphasized that physical safety provisions are not enough. It is also necessary to take account of the people in the system, who in turn respond to the organizational framework in which they are placed. The recognition of this aspect of achieving the required safety standards in terrestrial nuclear safety has led to the concept of safety culture: the commitment of individuals and organizations to the overriding priority of safety.

At an international level there are two established organizations that contribute to the safety culture. The nuclear industry supports the World Association of Nuclear Operators (WANO), dedicated to minimizing the risks of a further accident by improvements at the operational level; WANO operates to a large extent through peer-group pressure that ensures that no member can risk being accused of failing to comply with the spirit of WANO. The second organization, IAEA, commissioned its nuclear safety advisory group to publish a report on the safety culture concept (INSAG-4). Among the many elements it identified as contributing to safety culture are:

- Individual awareness of the importance of safety;
- Knowledge and competence, conferred by training and instruction of personnel and by their self-education;
- Commitment, requiring demonstration at the senior management level of the high priority of safety and adoption by individuals of the common goal of safety;
- Motivation, through leadership, the setting of objectives and systems of rewards and sanctions, and through individuals' self-generated attitudes;
- Supervision, including audit and review practices, with readiness to respond to individuals' questioning attitudes;
- Responsibility, through formal assignment and description of duties and their understanding of individuals.

In the context of NPS in outer space, much of the safety culture provision must be at the level of the country and organizations involved in the particular mission. However, in view of the high perceived risk of transnational accidents, the top layer of safety culture needs to be at the international level. It would be appropriate for the United Nations to act at this level, perhaps through an expert advisory committee to the Secretary-General operating by peer-group pressure to ensure that all satellites with NPS on board are designed, built and operated within an internationally acceptable safety culture.

Conclusions

In an attempt to make the safety principles for NPS in outer space more technology-independent and less likely to need regular revision, a new approach is proposed based on the accumulated experience of achieving acceptable safety standards with terrestrial nuclear power systems. The new principles require NPS systems to demonstrate:

- A net positive benefit;
- A maximum risk to individuals, society and the environment within tolerable limits;
- Risks reduced below these maximum tolerable limits to the extent justified by social and economic costs;
- Design, operation and decommissioning within a safety culture.

Given these principles with minimal elaboration, the remaining tasks for the Committee on the Peaceful Uses of Outer Space are then:

- To agree maximum tolerable and generally acceptable levels of risk;
- To provide the top layer of the safety culture, possibly in the form of an expert group to advise the Secretary-General on the adequacy of the measures taken to implement the new principles.



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USE OF NUCLEAR POWER SOURCES IN OUTER SPACE

Working paper submitted by the Russian Federation

In order to solve the problem of radiological safety of spacecraft carrying nuclear power sources (NPSs), it is important to study collisions of spacecraft carrying NPSs with space debris.

Bearing in mind the view of the Subcommittee regarding the need for detailed investigation of the problem of collisions between NPSs and space debris and for publication of the results of such investigations, the Russian Federation is submitting a working paper giving the results of calculations carried out in 1992 in the continuation of work done in 1991 under the Federation's overall programme to investigate the safety of space NPSs.

The paper considers possible collisions with space debris by the nuclear power reactors (NPRs) launched into space between 1970 and 1988 and located in orbits of 700-1,000 km.

Collision conditions were selected for the collision of a fuel element assembly with space debris in the form of steel fragments with a mass ranging from 0.25 kg and a linear dimension of 4 cm to a mass of 4.1 kg and a linear dimension of 10 cm. A study was made of the numerical modelling of a one-dimensional impact load applied to the laminated structure of a fuel element assembly consisting of 37 cylindrical fuel elements with annular beryllium reflectors and uranium-molybdenum alloy fuel pellets. The impact of fragments with a mass ranging from 0.25 kg to 4.1 kg and a velocity of 7.5 km/sec on the fuel element assembly was calculated. The initial parameters for the trajectory of the fuel element assembly before the collision were taken from data for the Cosmos-1900 satellite.

It was assumed in the calculations that, at the moment of collision, the fuel element assembly (target) and the debris (striker) are travelling at identical velocities at an angle of 90 degrees; i.e., the striker and the target are moving in orbits perpendicular to each other and the impact is directed along the longitudinal axis of the fuel element assembly.

The collision of a fuel element assembly with a 0.25-4.1-kg fragment of debris (striker) may be expected to cause disintegration of the fuel element assembly (target) into fragments with a mass of 0.1-1.3 kg (steel structural components), 0.04-0.3 kg (fuel pellets) and 0.056 kg (beryllium reflectors).

Given the limitations of the single numerical model selected at this stage of the research, the rates of deceleration in the direction of travel of the target remain unknown. These rates are assumed to represent a 50 per cent reduction compared with a perfectly elastic impact, and range from 35 m/sec for a striker with a 0.25-kg mass to 580 m/sec for a striker with a 4.1-kg mass. Additional impulses in the direction of travel of the striker may range from 30 m/sec to 3,400 m/sec, which, depending on the sign of the impulse, may significantly change the lifetime of the fragments of the target.

The change in flight trajectory parameters and in the lifetime of the fragments of the fuel element assembly after impact were calculated for the atmospheric model GOST 25645.115-84, which applies in the Russian Federation, with an average solar activity index of 106 and an average geomagnetic perturbation index of 2.667.

The lifetime of the fragments of the fuel element assembly ranges: for the steel structural components, from 100 to 10 years at 0-degree angles of entry into the atmosphere; for the fuel pellets, from 670 years at 0-degree angles of entry to 20 minutes at 1-degree to 8-degree angles of entry; for the beryllium reflectors, from 7.5 years to 40 minutes at 0-degree to 2-degree angles of entry.

Calculations of the aerodynamic characteristics of the fragments of the fuel element assembly, their movement dynamics around the centre of the masses during descent through the atmosphere, and their aerodynamic heating and disintegration, indicate that, with angles of entry into the atmosphere of about 0 degrees, the steel structural components are heated to melting point and disintegrate at great altitudes; the fuel-pellet fragments disintegrate fully at altitudes of 93-86 km with a combustion area covering 150-620 km; the beryllium reflectors disintegrate at altitudes of 78-52 km. At higher angles of entry into the atmosphere (1 degree to 8 degrees), the range of altitudes and the combustion area along the descent trajectory are lower and smaller. For example, a fuel pellet would be expected to disintegrate within a range of altitudes of 69-59 km with a combustion area of 66 km.

The results of calculations of the final particle size in the combustion of fuel-pellet fragments indicate that, at angles of entry into the atmosphere of about 0 degrees, the mean value of particle size is 200 microns and the range of particle size is 30-5,000 microns. At higher angles of entry into

the atmosphere (up to 8 degrees), the mean value of particle size is 100 microns and the range of particle size is 30-1,500 microns.

Assessment of the radiological consequences of the collision of NPSs with space debris should take into account the length of time the reactor will last after shut-down, i.e., the length of time it remains in orbit up to the moment of collision. The probability of collision of the NPS with space debris becomes significant when its lifetime exceeds 50 years. Consequently, the radiological consequences should be considered only for particles and fragments of the reactor fuel, since the induced movement of the reactor construction materials and the beryllium reflector cause virtual disintegration some 30-50 years after reactor shut-down.

Aerodynamic disintegration in the atmosphere of fragments of the beryllium reflectors will lead to the formation and fallout of particles resulting in a density of beryllium contamination of the soil that is lower than the natural beryllium content in the soil.

Aerodynamic disintegration of fuel-pellet particles with a lifetime of over 50 years may lead to the fallout of heavy fuel particles with a mass of up to 1.5 grams. The probability of the formation of such large particles is about 0.002.

Subsequent studies of issues involving the collision of NPSs with space debris envisage the development of a methodology for two-dimensional numerical modelling of the disintegration process using engineering functions for calculating the depth and diameter of the breakdown, the characteristics of secondary fragments and so on, based on experimental data.

Computer programs being developed for two-dimensional numerical modelling make it possible to define more precisely the dimensions of the fragments of the NPSs, the change in velocity of the fragments in the directions of travel of the striker and the target, and the change in the angle of orbit of the fragments. Forecasting of the navigational flight parameters of the fragments after impact, in combination with observational data, will make it possible to confirm the occurrence of a collision and to pinpoint the geographical coordinates of the point of entry into the atmosphere and the area of fallout.



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DRAFT REPORT OF THE SCIENTIFIC AND TECHNICAL SUBCOMMITTEE ON THE WORK OF ITS THIRTIETH SESSION

INTRODUCTION

1. The Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space held its thirtieth session at United Nations Headquarters from 16 to 26 February 1993 under the chairmanship of Professor J. H. Carver (Australia).
2. Representatives of the following Member States attended the session: Argentina, Australia, Austria, Belgium, Benin, Brazil, Bulgaria, Burkina Faso, Canada, Chile, China, Colombia, Czech Republic, Ecuador, Egypt, France, Germany, Greece, Hungary, India, Indonesia, Iran (Islamic Republic of), Iraq, Italy, Japan, Kenya, Lebanon, Mexico, Mongolia, Morocco, Netherlands, Nigeria, Pakistan, Philippines, Poland, Romania, Russian Federation, Sierra Leone, Spain, Sweden, Syrian Arab Republic, Ukraine, United Kingdom of Great Britain and Northern Ireland, United States of America, Uruguay, Venezuela and Viet Nam.
3. Representatives of the Department of Economic and Social Development, the Office of Legal Affairs, the United Nations Environment Programme and the United Nations Development Programme of the United Nations Secretariat attended the session.
4. Representatives of the following specialized agencies attended the session: Food and Agriculture Organization of the United Nations (FAO), United Nations Educational, Scientific and Cultural Organization (UNESCO), International Telecommunication Union (ITU) and World Meteorological Organization (WMO).

5. Representatives of the European Space Agency (ESA), the International Telecommunications Satellite Organization (INTELSAT), the Committee on Space Research (COSPAR) of the International Council of Scientific Unions (ICSU), the International Astronautical Federation (IAF) and the International Society for Photogrammetry and Remote Sensing (ISPRS) also attended the session.

6. A list of the representatives of Member States, specialized agencies and other international organizations attending the session is contained in document A/AC.105/C.1/INF/22.

7. On 16 February, the Subcommittee adopted the following agenda:

1. Adoption of the agenda.
2. Statement by the Chairman.
3. General exchange of views.
4. United Nations Programme on Space Applications and the coordination of space activities within the United Nations system.
5. Implementation of the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82).
6. Matters relating to remote sensing of the Earth by satellites, including, inter alia, applications for developing countries.
7. Use of nuclear power sources in outer space.
8. Questions relating to space transportation systems and their implications for future activities in space.
9. Examination of the physical nature and technical attributes of the geostationary orbit; examination of its utilization and applications, including, inter alia, in the field of space communications, as well as other questions relating to space communications developments, taking particular account of the needs and interests of developing countries.
10. Matters relating to life sciences, including space medicine.
11. Progress in national and international space activities related to the Earth environment, in particular progress in the geosphere-biosphere (global change) programme.
12. Matters relating to planetary exploration.
13. Matters relating to astronomy.

14. The theme fixed for special attention at the 1993 session of the Scientific and Technical Subcommittee: "Space-based communication: the expansion of current services and increased understanding of new systems and the services they will make possible".
15. Other matters.
16. Report to the Committee on the Peaceful Uses of Outer Space.

Meetings and documentation

8. The Subcommittee held ____ meetings.
9. A list of the documents which were before the Subcommittee is provided in annex I to the present report.
10. Following the adoption of the agenda, the Chairman made a statement outlining the work of the Subcommittee at its current session. He also reviewed the activities of Member States in the field of space exploration, including important advances that had been achieved as a result of international cooperation during the past year.
11. At the 417th, 418th, 421st, 422nd and 423rd meetings, the Chairman informed the Subcommittee that requests had been received from the permanent representatives of Bolivia, Costa Rica, Kazakhstan, Libyan Arab Jamahiriya, Portugal and Turkey, as well as from the Permanent Observer for the Holy See, to attend the session. Following past practice, those delegations were invited to attend the current session of the Subcommittee and to address it as appropriate. This was without prejudice to further requests of that nature and did not involve any decision of the Subcommittee concerning status, but was a courtesy that the Subcommittee extended to those delegations.
12. General statements were made by the following delegations: Argentina, Austria, Brazil, Canada, Chile, China, France, Germany, Hungary, India, Indonesia, Morocco, Nigeria, Pakistan, Poland, Russian Federation, Sweden, United Kingdom and Uruguay. General statements were also made by the representatives of COSPAR, IAF, ISPRS and INTELSAT.
13. At the 417th meeting, the Chief of the Office for Outer Space Affairs made a statement reviewing the work programme of the Office. At the 421st meeting, the Expert on Space Applications made a statement outlining the activities carried out and planned under the United Nations Programme on Space Applications.

Technical presentations

14. In accordance with paragraph 8 (b) (vii) of General Assembly resolution 47/67 of 14 December 1992, a symposium on the theme "Space-based communication: the expansion of current services and increased understanding

of new systems and the services they will make possible" was organized by COSPAR and IAF to complement discussions within the Subcommittee on the special theme. The symposium was co-chaired by Mr. George Ohring, Chairman of the COSPAR Commission on Space Studies of the Earth's Surface, Meteorology and Climate, and Mr. Dale Fester, Vice President, IAF. The presentations included: "The Changing Environment for Global Communications" by Mr. Richard C. Kirby, Director, International Radio Consultative Committee, ITU; "The Changing Dynamics at INTELSAT" by Mr. D. K. Sachdev, Director, Communications Engineering and System Planning, INTELSAT; "The Changing Dynamics at INMARSAT" by Mr. Jai Singh, General Manager, Project 21, INMARSAT; "The Movement to Global Personal Communications Services" by Mr. Peter Swan, Manager, Systems Engineering, Motorola; "Disaster Mitigation: The Critical Communication Link" by Mr. Ray J. Arnold, Acting Director for Commercial Innovation and Competitiveness, Office of Advanced Concepts and Technology, National Aeronautics and Space Administration (NASA), United States; "Telemedicine for the Globe: The West African Case Study" by astronaut Mae C. Jemison, NASA; "Satellite Communications for Development" by Mr. Oetarjo Diran, Deputy Chairman, National Institute of Aeronautics and Space (LAPAN), Indonesia; and "Satellite Communications in China" by Prof. Yiyuan Chen, Chief Engineer, Institute of Space Technology, Ministry of Aeronautics and Space, China.

15. In response to General Assembly resolution 47/67, Mr. Hugues Laporte-Weywada of the Directorate of Launchers, Centre National d'Etudes Spatiales, France, made a special presentation on the complex issue of space debris and the solutions currently being adopted at the national level, taking into account the work performed within the ad hoc working group of experts of IAF on the issue.

16. During the course of the session, scientific and technical presentations were made by Astronaut Mae C. Jemison, NASA, on human space flight; by Mr. V. V. Alaverdov, First Deputy Head, Russian Space Agency, on the activities of the Russian Space Agency; by Mr. Mouslim Kabbaj, Director, Royal Centre for Remote Sensing, Morocco, on "Remote Sensing for Groundwater Applications"; by Dr. Janis Stoklosa, Manager, Space Human Factors Program, NASA, on "Putting Humans in Space, Helping People on Earth"; by Dr. Cherilyn Morrow, Visiting Senior Scientist, NASA Astrophysics Division, on "Astronomy and Astrophysics"; by Ms. Corinne Buoni, Senior Technology Analyst, Solar Exploration Division, NASA, on "Solar System Exploration", and by Mr. Noah Samara, Chief Executive, Afrispace, on "Radio Broadcasting Services for Africa: Emerging Developments".

Recommendations of the Scientific and Technical Subcommittee

17. After considering the various items before it, the Subcommittee, at its ____th meeting, on 26 February 1993, adopted its report to the Committee on the Peaceful Uses of Outer Space containing its views and recommendations as set out in the paragraphs below.

I. UNITED NATIONS PROGRAMME ON SPACE APPLICATIONS AND
THE COORDINATION OF SPACE ACTIVITIES WITHIN THE
UNITED NATIONS SYSTEM

II. IMPLEMENTATION OF THE RECOMMENDATIONS OF THE SECOND
UNITED NATIONS CONFERENCE ON THE EXPLORATION AND
PEACEFUL USES OF OUTER SPACE

18. In accordance with General Assembly resolution 47/67, the Subcommittee continued its consideration of these items. In accordance with past practice, the Subcommittee considered the two items jointly.

19. The Subcommittee noted that the General Assembly, in paragraph 14 of resolution 47/67, had once again emphasized the urgency and importance of implementing fully the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82) as early as possible. The Subcommittee also took note of paragraph 9 of the same resolution, in which the General Assembly considered that, in the context of the Subcommittee's consideration of the item, it was particularly urgent to implement the following recommendations:

"(a) All countries should have the opportunity to use the techniques resulting from medical studies in space;

"(b) Data banks at the national and regional levels should be strengthened and expanded and an international space information service should be established to function as a centre of coordination;

"(c) The United Nations should support the creation of adequate training centres at the regional level, linked, whenever possible, to institutions implementing space programmes; necessary funding for the development of such centres should be made available through financial institutions;

"(d) The United Nations should organize a fellowship programme through which selected graduates or postgraduates from developing countries should get in-depth, long-term exposure to space technology or applications; it is also desirable to encourage the availability of opportunities for such exposure on other bilateral and multilateral bases outside the United Nations system."

20. In response to the recommendations of the Working Group of the Whole to Evaluate the Implementation of the Recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space, as contained in its report on the work of its sixth session, held in 1992 (A/AC.105/513, annex II, paras. 6-20), which were endorsed by the General Assembly in paragraph 11 of resolution 47/67, the Subcommittee had before it the following documents: a report on international cooperation in the peaceful uses of outer space: activities of Member States (A/AC.105/523), containing information submitted by Member States in response to paragraph 10 of the report of the Working Group; a review of the applications of space

technology on remote and rural communications (A/AC.105/536), in response to paragraph 17 (ii); a study on applications of space technology to ocean resource development (A/AC.105/535), in response to paragraph 17 (iv). In addition, the Subcommittee had before it annual reports, including information in response to paragraph 11, submitted by the following international organizations: WMO (A/AC.105/537 and A/AC.105/538); ESA (A/AC.105/539); INTELSAT (A/AC.105/540); International Maritime Satellite Organization (INMARSAT) (A/AC.105/541); and ITU.

21. In accordance with paragraph 10 of General Assembly resolution 47/67, the Subcommittee reconvened the Working Group of the Whole with a view to improving the execution of activities relating to international cooperation, particularly those included in the United Nations Programme on Space Applications, and to proposing concrete steps to increase such cooperation as well as to make it more efficient. The Working Group was chaired by Mr. Muhammad Nasim Shah (Pakistan); it held ____ meetings between 18 and ____ February 1993 and adopted its report (A/AC.105/C.1/WG.6/L.8) on ____ February 1993.

22. Having considered the report of the Working Group of the Whole, the Subcommittee decided at its ____th meeting, on ____ February 1993, to adopt that report, as contained in annex II to the present report, on the understanding that the recommendations contained therein would be carried out in accordance with paragraph 9 of General Assembly resolution 37/90 of 10 December 1982. The Subcommittee recommended that the Working Group be reconvened next year to continue its work.

A. United Nations Programme on Space Applications

23. Regarding the expanded United Nations Programme on Space Applications, the Subcommittee had before it the report of the United Nations Expert on Space Applications (A/AC.105/533). The report was supplemented by the statement by the Expert. The Subcommittee noted that the Programme on Space Applications for 1992 had been carried out satisfactorily and commended the work accomplished by the Expert in carrying out the work programme as endorsed by the Subcommittee at its last session.

24. The Subcommittee noted with appreciation that since its last session additional contributions had been offered by various Member States and organizations and that they had been acknowledged with appreciation in paragraph 54 of the Expert's report.

25. The Subcommittee continued to express its concern over the limited financial resources available for carrying out the Programme and appealed to Member States to support the Programme through voluntary contributions. The Subcommittee felt that the limited resources of the United Nations should be focused on the highest priority activities and noted that the Programme on Space Applications was the priority activity of the Office for Outer Space Affairs.

26. The Subcommittee noted that, in response to the report of the Subcommittee at its last session, the Committee on the Peaceful Uses of Outer Space had requested the General Assembly to make an adequate allocation for the Programme on Space Applications in order to fully implement the recommendations of UNISPACE 82. The Subcommittee noted that the Special Political Committee of the General Assembly, in considering the report of the Committee on the Peaceful Uses of Outer Space, had decided to accede to that request and that the Chairman of the Special Political Committee had conveyed that decision in a letter to the Chairman of the Fifth Committee of the General Assembly (A/C.5/47/51). On the recommendation of the Fifth Committee, the General Assembly, in resolution 47/219 of 23 December 1992, took note of the letter from the Chairman of the Special Political Committee. The Subcommittee expressed its hope that those recommendations and actions would be reflected in an adequate allocation for the Programme on Space Applications in the 1994-1995 budget.

1. 1992-1993

(a) United Nations training courses, workshops, conferences and symposia

27. With regard to the activities of the programme carried out in 1992, the Subcommittee expressed its appreciation to:

(a) The Governments of Ecuador and Japan for co-sponsoring the United Nations Workshop on Space Technology for Resource Development and Environmental Management hosted by the Centro de Levantamientos Integrados de Recursos Naturales por Sensores Remotos (CLIRSEN) in Quito from 9 to 13 March 1992;

(b) The Government of Sweden, represented by the Swedish Agency for International Technical and Economic Cooperation (BITS), for co-sponsoring the second United Nations Training Course in Remote Sensing Education for Educators hosted by Stockholm University and the Swedish Space Corporation Satellitbild and held in Stockholm and Kiruna from 11 May to 1 June 1992;

(c) The Government of the United States, represented by NASA, the National Oceanic and Atmospheric Administration (NOAA), the United States Geological Survey and the Consortium for International Earth Science Information Network, for co-sponsoring the United Nations/United States International Conference on Satellite Remote Sensing for Resource Management, Environmental Assessment and Global Change Studies: Needs and Applications of Developing Countries held in Boulder, Colorado, from 17 to 20 August 1992;

(d) The Government of Germany as well as the Carl Duisberg Gesellschaft for co-sponsoring the fourth United Nations International Training Course on Remote Sensing Applications to Geological Science hosted by the GeoResearch Centre, Potsdam, and the Free University of Berlin from 28 September to 16 October 1992;

(e) ESA for co-sponsoring the Regional Training Course on the use of Remote Sensing Systems in Hydrological and Agrometeorological Applications hosted by the Regional Centre for Services in Surveying, Mapping and Remote Sensing (RCSSMRS), Nairobi, from 12 to 30 October 1992;

(f) The Governments of Costa Rica and Colombia as well as ESA and the Planetary Society for co-sponsoring the second United Nations/ESA/Planetary Society Workshop on Basic Space Science hosted by the University of Costa Rica, San José, and the International Centre for Physics (CIF) and the University of the Andes, Santa Fe de Bogotá, and held from 2 to 7 November 1992 in San José and from 9 to 13 November 1992 in Santa Fe de Bogotá;

(g) The Government of the Republic of Korea for co-sponsoring and hosting the United Nations Workshop on Space Communications for Development, held in Seoul from 24 to 28 November 1992.

28. The Subcommittee took note of the status of the United Nations workshops, training courses and conferences being held in 1993, which included the following activities, as described in paragraph 42 of the Expert's report:

(a) A United Nations/ESA Training Course for African Francophone Countries on Applications of the European Remote Sensing Satellite (ERS-1) for Natural Resources, Renewable Energy and Environment to be organized in cooperation with the Department of Economic and Social Development and held at the European Space Research Institute (ESRIN) in Frascati, Italy, from 19 to 30 April 1993;

(b) The Third United Nations/Sweden Training Course on Remote Sensing Education for Educators, to be organized in cooperation with the Government of Sweden and held in Stockholm and Kiruna from 3 May to 4 June 1993;

(c) A United Nations Workshop on Space Communications for Development for the benefit of Member States of the Mediterranean and adjacent areas, to be organized in cooperation with the Government of Greece and held in Athens from 10 to 12 May 1993;

(d) A United Nations Regional Conference on Space Science Technology for Sustainable Development for the benefit of countries of the region of the Economic and Social Commission for Asia and the Pacific (ESCAP), to be organized in cooperation with the Government of Indonesia and held in Bandung, from 17 to 21 May 1993;

(e) A United Nations/Office of the United Nations Disaster Relief Coordinator (UNDRO)/ESA Workshop on Applications of Space Technology to combat Natural Disasters, for the benefit of Member States in the region of the Economic Commission for Latin America and the Caribbean (ECLAC), to be organized in cooperation with the Government of Mexico in September 1993;

(f) A United Nations Regional Conference on Africa's Environmental and Natural Resources Information and Management Needs, to be organized in cooperation with the Government of Senegal in October 1993;

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(g) A United Nations/IAF/ESA Symposium on Organizing Space Activities in Developing Countries: Resources and Mechanisms, to be organized in cooperation with the Government of Austria and IAF and held in Graz from 18 to 22 October 1993;

(h) A United Nations Workshop on the Use of Space Techniques for Monitoring and Control of Desert Environments, to be organized for the benefit of Member States in the region of the Economic and Social Commission for West Asia (ESCWA) and held in November 1993;

(i) A United Nations Workshop on Basic Space Science, to be organized for the benefit of Member States in Africa in November 1993.

(b) Long-term fellowships for in-depth training

29. The Subcommittee expressed appreciation to the Governments of Brazil and China as well as to ESA for having offered training fellowships in various areas relating to space activities for the period 1991-1992. The Subcommittee once again expressed appreciation to those Governments and agencies for the renewal of fellowships for the period 1992-1993. The Status of the 1992-1993 fellowships and the countries whose candidates have received fellowships are indicated in annex II to the Expert's report (A/AC.105/533).

30. The Subcommittee noted that it was important to increase the opportunities for in-depth education in all areas of space science, technology and applications projects through long-term fellowships.

(c) Technical advisory services

31. The Subcommittee took note of the technical advisory services being provided by the Office for Outer Space Affairs in support of regional space applications projects, as indicated in the report of the Expert:

(a) Collaboration with ESA on a survey and selection of projects to receive remote sensing data made available by ESA to African countries covered by ESA's two remote sensing ground receiving stations at Maspalomas, Spain, and Fucino, Italy;

(b) Assistance to the Government of Ecuador in promoting regional operation, administration and funding of the remote sensing receiving station at Cotopaxi, Ecuador;

(c) Assistance to the Government of Chile in the preparation of the Second Space Conference of the Americas;

(d) Cooperation with the Government of Nigeria in a seminar on space science and technology;

(e) Cooperation with the Government of the Islamic Republic of Iran in a seminar on remote sensing of the environment and space applications;

(f) Assistance to the Government of the Republic of Korea in the establishment of the Asia-Pacific Satellite Communications Conference;

(g) Cooperation with the Indian Ocean Marine Affairs Cooperation (IOMAC) programme in the development of remote sensing projects for coastal zone management and monitoring.

(d) Promotion of greater cooperation in space science and technology

32. The Subcommittee noted that the United Nations was collaborating with international professional bodies in the space community to promote exchange of experience on space activities. In 1992, the Programme on Space Applications co-sponsored the following activities:

(a) The United Nations and ISPRS collaborated in a joint United Nations/ISPRS Workshop on Remote Sensing Data Analysis Methods and Applications, held in Washington, D.C., on 6 and 7 August 1992 during the ISPRS Congress for the benefit of scientists from developing countries;

(b) The United Nations co-sponsored a United Nations/IAF/COSPAR/American Institute of Aeronautics and Astronautics (AIAA) Symposium on Space Technology in Developing Countries - Making it Happen, held in Washington, D.C. from 28 to 30 August 1992 in conjunction with the COSPAR/IAF World Space Congress.

2. 1994

(a) United Nations training courses, workshops and symposia

33. The Subcommittee recommended the approval of the following programme of training courses, workshops and symposia proposed for 1994:

(a) The Fifth United Nations Training Course on Remote Sensing Applications to Geological Sciences, to be organized in cooperation with the Government of Germany and the Carl Duisberg Gesellschaft and held in the ESCAP region in early 1994;

(b) A United Nations International Workshop on Spin-off Benefits of Space Technology;

(c) The Fourth United Nations/Sweden International Training Course on Remote Sensing Education for Educators, to be held in Stockholm and Kiruna, Sweden;

(d) A United Nations International Training Course on Communications Technology for Development;

(e) A United Nations Microwave Remote Sensing Training Course for the benefit of ESCAP and ESCWA Member States;

(f) A United Nations/UNDRO Regional Workshop on Space Technology to Combat Natural Disasters for the benefit of Member States in the ECA region;

(g) A United Nations Regional Training Course on Remote Sensing Applications for the benefit of ECLAC Member States;

(h) A United Nations Workshop on Basic Space Science in Development Programmes for the benefit of ESCAP and ESCWA Member States;

(i) A United Nations International Workshop on the Development and Design of Small Experimental Payloads; and

(j) A United Nations/IAF Symposium on Space Technology in Developing Countries.

B. International space information service

34. The Subcommittee noted with satisfaction that the Office for Outer Space Affairs was in the process of developing an international space information system, including both information within the United Nations system and access to external databases.

35. The Subcommittee noted with satisfaction the publication of documents entitled "Seminars of the United Nations Programme on Space Applications: Selected Papers on Remote Sensing, Satellite Communications and Space Science" (A/AC.105/532); "Directory of Information Systems on Space Science Technology" (A/AC.105/517); and "Space Activities of the United Nations and International Organizations" (A/AC.105/521). It also noted that the Secretariat was preparing an updated edition of the Directory on Education, Training, Research, and Fellowship Opportunities in Space Science and Technology and its Applications (A/AC.105/432).

C. Reports

36. The Subcommittee took note with appreciation of the reports submitted to it by Member States and international organizations in response to the recommendations of the Working Group of the Whole in its report on the work of its sixth session (A/AC.105/513, annex II, paras. 6-20). It also noted the technical studies prepared by the Secretariat on space applications for ocean resource development (A/AC.105/535) and on applications of space technology for remote and rural communications and broadcasting (A/AC.105/536).

D. Coordination of space activities within the United Nations system and inter-agency cooperation

37. The Subcommittee noted that the General Assembly, in resolution 47/67, had reaffirmed its request that all organs, organizations and bodies of the United Nations system and other intergovernmental organizations working in the

field of outer space or on space-related matters should cooperate in the implementation of the recommendations of UNISPACE 82.

38. The Subcommittee noted with satisfaction that the Inter-Agency Meeting on Outer Space Activities had been convened by the Administrative Committee on Coordination (ACC) at UNESCO headquarters in Paris, from 5 to 7 October 1992 and that its report (ACC/1992/28) was before the Subcommittee. The Subcommittee took note of the information provided on the progress achieved in coordinating the space activities of the organizations of the United Nations system and expressed its appreciation for the report of the Secretary-General entitled "Coordination of outer space activities within the United Nations system: programmes of work for 1993 and 1994 and future years" (A/AC.105/524).

39. The Subcommittee continued to stress the necessity of ensuring continuous and effective consultations and coordination in the field of outer space activities among organizations within the United Nations system and the avoidance of duplication of activities.

E. Regional and interregional cooperation

40. The Subcommittee noted that the General Assembly, in its resolution 47/67, had reaffirmed its approval of the recommendations of UNISPACE 82 regarding the establishment and strengthening of regional mechanisms of cooperation and their promotion and creation through the United Nations system. The Subcommittee noted with satisfaction that, in carrying out various activities in the implementation of the recommendations of UNISPACE 82, the Secretariat had sought to strengthen those mechanisms.

41. The Subcommittee noted with appreciation the efforts undertaken as part of the United Nations Programme on Space Applications, in accordance with the UNISPACE 82 recommendation concerning the development of indigenous capabilities, to establish regional centres for space science and technology education in existing national or regional educational institutions in developing countries, as outlined in the report entitled "Centres for Space Science and Technology Education: Updated Project Document" (A/AC.105/534).

42. The Subcommittee noted with appreciation the offers by a number of Member States to host such regional centres and indications of support from other Member States. The Subcommittee noted that an evaluation mission concerning the establishment of such a regional centre had been undertaken to a number of potential host countries and institutions in Latin America, and that representatives from potential supporting Governments had participated in that mission. The Subcommittee noted that similar evaluation missions were being planned for other regions. The Subcommittee urged other Member States to support the establishment of the centres and requested the Office for Outer Space Affairs to make every possible effort to obtain the support of other relevant international organizations. The Subcommittee requested that it be kept informed of further developments on the subject.

43. The Subcommittee noted that the Second Space Conference of the Americas was being hosted by the Government of Chile in Santiago from 26 to 30 April 1993 and would promote cooperation in space activities primarily for the benefit of countries in the Latin American and Caribbean region. The Subcommittee also noted that the Regional Conference on Space Science and Technology for Sustainable Development, to be held in Indonesia in May 1993, and the Regional Conference on Africa's Environmental and Natural Resources Information and Management Needs, to be held in Senegal in October 1993, would promote regional cooperation for the benefit of countries in those regions.

44. The Subcommittee noted the contributions made by other international organizations towards the promotion of international cooperation in space activities: FAO was continuing its activities relating to remote sensing of renewable natural resources and environmental monitoring, including training courses and support of development projects; ITU was continuing its work in the international coordination of space communications, including providing technical assistance to developing countries; WMO was continuing international cooperative programmes using space technology, including the World Weather Watch and the Tropical Cyclone Programme; INMARSAT was continuing to develop its satellite communication system for maritime, aeronautical and land-mobile communications, including the development of small, low-cost terminals and the provision of technical assistance and training; INTELSAT was further developing its system for international satellite communications and broadcasting, including its programmes for training and technical assistance; ESA was continuing its programme of international cooperative space activities, including training programmes for the benefit of developing countries, support of the activities of the United Nations Programme on Space Applications and technical assistance projects.

45. The Subcommittee emphasized the importance of regional and international cooperation in making the benefits of space technology available to all countries, through such cooperative activities as shared payloads, dissemination of information on spin-off benefits, ensuring compatibility of space systems and providing access to launch capabilities at reasonable cost.



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COMMITTEE ON THE PEACEFUL USES
OF OUTER SPACE

DRAFT REPORT OF THE SCIENTIFIC AND TECHNICAL SUBCOMMITTEE
ON THE WORK OF ITS THIRTIETH SESSION

Addendum

III. MATTERS RELATING TO REMOTE SENSING OF THE EARTH BY
SATELLITES INCLUDING, INTER ALIA, APPLICATIONS FOR
DEVELOPING COUNTRIES

1. In accordance with General Assembly resolution 47/67, the Subcommittee continued its consideration of this item.
2. In the course of the debate, delegations reviewed the national and cooperative programmes in remote sensing. Examples were given of national programmes in developing and developed countries and of international programmes based on bilateral, regional and international cooperation, including programmes of technical cooperation between developing countries. Countries with advanced capabilities in the field, including some developing countries, described programmes to provide assistance to other developing countries.
3. The Subcommittee took note of the continuing programmes of China, France, India, Japan, the Russian Federation, the United States and ESA for remote-sensing satellites as well as the planned remote-sensing satellite systems of Brazil and Canada. The Subcommittee noted that the recent launches of the European Remote Sensing (ERS-1) satellite and the Japanese Earth Resources Satellite (JERS-1) would provide valuable microwave data to complement the multispectral data from satellites of the Landsat, Resurs, SPOT, Indian Remote Sensing (IRS) and Marine Observation Satellite (MOS) series. It also took note of the activities of FAO in remote sensing of renewable natural resources, including land-cover mapping and geographic information systems, of the initiative of UNESCO for the establishment of satellite data centres, of the work of WMO in the areas of weather forecasting

and storm warning and of ISPRS in promoting international cooperation in remote sensing and image processing.

4. The Subcommittee reiterated its view that remote-sensing activities should take into account the need to provide appropriate and non-discriminatory assistance to meet the needs of the developing countries.

5. The Subcommittee emphasized the importance of making remote-sensing data and analysed information openly available to all countries at reasonable cost and in a timely manner. The Subcommittee also recognized the need for continuing free access to data from operational meteorological satellites.

6. The Subcommittee felt that international cooperation in the use of remote-sensing satellites should be encouraged, both through coordination of the operations of ground stations and through regular meetings between satellite operators and users. It noted the importance of compatibility and complementarity of existing and future remote-sensing systems. The Subcommittee also noted the importance, particularly for the developing countries, of sharing experiences and technologies, of cooperation through international and regional remote-sensing centres and of joint work on collaborative projects.

7. Recalling General Assembly resolution 41/65 of 3 December 1986, by which the Assembly had adopted the Principles Relating to Remote Sensing of the Earth from Outer Space, the Subcommittee recommended that at its thirty-first session it continue its discussion on remote-sensing activities conducted in accordance with those Principles, during its consideration of the agenda item concerning remote sensing.

8. The Subcommittee recommended that the item be retained on its agenda as a priority item for the next session.

IV. USE OF NUCLEAR POWER SOURCES IN OUTER SPACE

9. In accordance with General Assembly resolution 47/67, the Subcommittee continued its consideration of this item.

10. The Subcommittee noted with satisfaction that, on the basis of many years of work in the Committee and its subcommittees, the General Assembly had adopted a Set of Principles Relevant to the Use of Nuclear Power Sources in Outer Space, as contained in resolution 47/68 of 14 December 1992. The Subcommittee also noted that the Principles provided that they should be reopened for revision by the Committee on the Peaceful Uses of Outer Space no later than two years after their adoption.

11. In accordance with General Assembly resolution 47/67, the Working Group on the Use of Nuclear Power Sources in Outer Space was reconvened to resume its work at the current session. The Working Group met from 22 to February under the chairmanship of Professor J. H. Carver (Australia). At a meeting held on February 1993, the Working Group adopted its report.

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12. At its th meeting, on February 1993, the Subcommittee adopted the report of the Working Group, which is contained in annex III to the present report.

13. The Subcommittee noted that in response to its recommendation, the General Assembly, in resolution 47/67, had invited Member States to report to the Secretary-General on a regular basis with regard to national and international research concerning the safety of nuclear-powered satellites. The Subcommittee also noted that the General Assembly, in the same resolution, had considered that, to the extent possible, information on the problem of collisions of space objects, including nuclear power sources, with space debris should be provided to the Scientific and Technical Subcommittee in order to allow it to follow this area more closely. The Subcommittee noted that a number of Member States had submitted information in response to those requests, as contained in document A/AC.105/542 and Add.1 and 2.

14. The Subcommittee agreed that Member States should continue to be invited to report to the Secretary-General on a regular basis with regard to national and international research concerning the safety of nuclear-powered satellites. The Subcommittee also agreed that further studies should be conducted on the problem of the collision of nuclear power sources with space debris and that it should be kept informed of the results of such studies.

15. The Subcommittee took note of working papers submitted by the United Kingdom (A/AC.105/C.1/L.187) and the Russian Federation (A/AC.105/C.1/L.188) on safety aspects of nuclear power sources in space, and a paper circulated by Pakistan (S&T/1993/CRP.2) on risks and radiological consequences of debris collisions with nuclear power sources in space.

16. The Subcommittee recommended that the item be retained on its agenda for the next session. The Subcommittee also recommended that the Working Group on the Use of Nuclear Power Sources in Outer Space be reconvened at its next session.

V. QUESTIONS RELATING TO SPACE TRANSPORTATION SYSTEMS AND THEIR IMPLICATIONS FOR FUTURE ACTIVITIES IN SPACE

17. In accordance with General Assembly resolution 47/67, the Subcommittee continued its consideration of this item.

18. In the course of the discussion, delegations reviewed national and international cooperative programmes in space transportation systems, including expendable launchers, reusable space shuttles and space stations. In particular, the Committee noted that China was continuing the use and development of its Long March series of launch vehicles; that India was continuing development of the Augmented Satellite Launch Vehicle, the Polar Satellite Launch Vehicle and the Geostationary Satellite Launch Vehicle; that Japan was continuing its development of the H-II and M-5 launch vehicles; that the Russian Federation had launched 78 space objects of various types using

expendable launchers of the Soyuz, Cosmos, Proton, Tsyklon and other series, and had sent a number of national and international crews to the Mir space station; that the United States was continuing its programme of expendable launches and flights of the reusable Space Shuttle and was developing the Space Station Freedom in cooperation with Canada, Japan and ESA; and that ESA was continuing development of the Ariane series of launch vehicles. The Subcommittee heard a special presentation by a United States astronaut on a Space Shuttle/Spacelab mission that conducted microgravity experiments, as mentioned in paragraph of the present report.

19. The Subcommittee took note of developments in low-cost microsatellite technology and applications that could allow more countries to take an active part in space activities.

20. The Subcommittee stressed the importance of international cooperation in space transportation in order to provide all countries with access to the benefits of space science and technology.

21. The Subcommittee recommended that consideration of the item be continued at its next session.

VI. EXAMINATION OF THE PHYSICAL NATURE AND TECHNICAL ATTRIBUTES OF THE GEOSTATIONARY ORBIT; EXAMINATION OF ITS UTILIZATION AND APPLICATIONS, INCLUDING, INTER ALIA, IN THE FIELD OF SPACE COMMUNICATIONS, AS WELL AS OTHER QUESTIONS RELATING TO SPACE COMMUNICATIONS DEVELOPMENTS, TAKING PARTICULAR ACCOUNT OF THE NEEDS AND INTERESTS OF DEVELOPING COUNTRIES

VII. THE THEME FIXED FOR SPECIAL ATTENTION AT THE 1993 SESSION:
"SPACE-BASED COMMUNICATION: THE EXPANSION OF CURRENT SERVICES AND INCREASED UNDERSTANDING OF NEW SYSTEMS AND THE SERVICES THEY WILL MAKE POSSIBLE"

22. In accordance with General Assembly resolution 47/67, the Subcommittee continued its consideration of the item relating to the geostationary orbit and space communications and considered the special theme.

23. In accordance with General Assembly resolution 47/67, the Subcommittee paid special attention to the theme "Space-based communication: the expansion of current services and increased understanding of new systems and the services they will make possible". The Subcommittee noted with satisfaction that, at its invitation, COSPAR and IAF had organized a symposium on the theme on 16 and 17 February 1993 (see para. above). The Subcommittee expressed appreciation to COSPAR and IAF for the very instructive symposium.

24. In the course of the discussion, delegations reviewed national and international cooperative programmes in satellite communications, including progress in communication satellite technology that would make satellite communications more accessible and less expensive and increase the

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communications capacity of the geostationary orbit and the electromagnetic spectrum.

25. The Subcommittee took note of the growing use of communication satellite systems for telecommunications, television broadcasting, data networks, environmental data relay, mobile communications, disaster warning and relief, telemedicine and other communication functions. The Subcommittee also took note of studies and research on the use of multiple, low-orbiting satellites for mobile and other communication services.

26. Some delegations expressed the view that the geostationary orbit was a limited natural resource and that saturation should be avoided in order to ensure that all countries had non-discriminatory access to the orbit. Those delegations felt that a special regime was required to ensure equitable access by all States, particularly developing countries. They felt that the roles of ITU and the Committee on the Peaceful Uses of Outer Space with respect to the geostationary orbit were complementary. Other delegations expressed the view that questions relating to the geostationary orbit were being addressed effectively in ITU.

27. Some delegations noted that the use of the geostationary orbit, like other orbits, was affected by the problem of space debris and that efforts were needed to minimize the generation of debris in the orbit and to move satellites shortly before the end of their useful lives into disposal orbits beyond the geostationary orbit.

28. The Subcommittee noted the use of the Cospas/Sarsat search-and-rescue satellite system developed and operated on the basis of international cooperation. The Subcommittee recommended that countries not already participating in that programme consider doing so.

29. The Subcommittee recommended that consideration of the item relating to the geostationary orbit and space communications be continued at its next session.

VIII. PROGRESS IN NATIONAL AND INTERNATIONAL SPACE ACTIVITIES RELATED TO THE EARTH ENVIRONMENT, IN PARTICULAR PROGRESS IN THE GEOSPHERE-BIOSPHERE (GLOBAL CHANGE) PROGRAMME

30. In accordance with General Assembly resolution 47/67, the Subcommittee continued its consideration of the item concerning progress in national and international space activities related to the Earth environment, in particular progress in the International Geosphere-Biosphere (Global Change) Programme.

31. The Subcommittee noted that the Secretariat, at the request of the Committee and the General Assembly, was preparing an analytical study on the role that the Committee could play in view of the decisions and recommendations of the United Nations Conference on Environment and Development, held at Rio de Janeiro in June 1992. The Subcommittee noted that

the General Assembly had invited Member States to submit their views on the subject in time for inclusion in that study and urged Member States to respond to that request.

32. The Subcommittee noted the progress being made through international cooperation in the International Geosphere-Biosphere Programme, with the participation of many countries. It noted that such a joint international effort was of fundamental importance for examining the future habitability of the planet and for managing the common natural resources of the Earth. The Subcommittee took particular note of the need to involve as many nations as possible in the scientific activities of the Programme, both in developed and in developing countries.

33. The Subcommittee took note of the important contributions of satellite remote sensing for environmental monitoring, for planning sustainable development, for water resource development, for monitoring crop conditions and for predicting and assessing drought.

34. The Subcommittee noted the important contribution of meteorological and atmospheric research satellites for studying global climate change, the greenhouse effect, the degradation of the ozone layer and other global environmental processes. The recent launches of the Topex/Poseidon oceanographic satellite, the Upper Atmosphere Research Satellite and the Total Ozone Mapping System have provided important new tools for this purpose. The Subcommittee noted the need for further space research relating to climate change, weather patterns, vegetation distribution, storm and flood risk and other environmental factors.

35. The Subcommittee noted the importance of international cooperation in the various existing and planned satellite systems for environmental monitoring. It recommended that other States consider participating in such cooperative activities.

36. The Subcommittee recommended that consideration of the item be continued at its next session.



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Addendum

IX. MATTERS RELATING TO LIFE SCIENCES, INCLUDING SPACE MEDICINE

1. In accordance with General Assembly resolution 47/67, the Subcommittee continued its consideration of this item. The Subcommittee heard a special presentation on the question by an expert from the United States, as mentioned in paragraph of the present report.
2. The Subcommittee recalled that the General Assembly, in resolution 47/67, had considered it particularly important that all countries should have the opportunity to use the techniques resulting from medical studies in space.
3. The Subcommittee noted that studies of human and animal physiology under the microgravity conditions of space flight had led to important advances in medical knowledge in such areas as blood circulation, sensory perception, immunology and the effects of cosmic radiation. It noted that important new information in these fields had been obtained through experiments on the Mir space station, the United States Space Shuttle, the United States/ESA Spacelab, the European Recoverable Carrier (Eureca), biological satellites and sounding rockets.
4. The Subcommittee noted that applications of space technologies were demonstrating growing promise in medicine and public health on Earth. Satellite communications for telemedicine were providing expert medical advice to distant areas, as illustrated by the Telemedicine Spacebridge linking medical centres in the United States and the Russian Federation. The Subcommittee also noted that products of space biotechnology, such as pharmaceuticals and medical instruments, could contribute to improved health care. The Subcommittee noted the importance of space technology for these

purposes and encouraged further research and exchange of information on those applications.

5. The Subcommittee noted that space studies in life sciences and medicine had important potential benefits for all countries and that efforts should be made to promote international cooperation to enable all countries to benefit from those advances.

6. The Subcommittee recommended that consideration of the item be continued at its next session.

X. MATTERS RELATING TO PLANETARY EXPLORATION

XI. MATTERS RELATING TO ASTRONOMY

7. In accordance with General Assembly resolution 47/67, the Subcommittee continued its consideration of these items. The Subcommittee heard special presentations on the items by experts from the United States, as mentioned in paragraph of the present report.

8. The Subcommittee noted that several planetary exploration missions were currently under way. The Magellan spacecraft was completing its systematic radar mapping programme of Venus. The Galileo spacecraft was on its way to Jupiter, having passed around Venus and the Earth and made close observations of the asteroid Gaspia. The Ulysses spacecraft, following its swing-by manoeuvre of Jupiter, was moving away from the plane of the solar system on its way to observe the polar regions of the Sun. The Mars Observer was en route to make close observations of Mars. The Giotto spacecraft had been reactivated to make observations of the comet Grigg-Skjellerup. The Subcommittee also noted the plans for future spacecraft to conduct comprehensive investigations of Mars and Saturn and its moons. The Subcommittee noted the high degree of international cooperation in all of those investigations and stressed the need to further enhance international cooperation in planetary exploration to enable all countries to benefit from and participate in those activities.

9. The Subcommittee noted that the use of spacecraft for making astronomical observations from above the atmosphere had greatly advanced knowledge of the universe by allowing observations in all regions of the electromagnetic spectrum. It noted that with the Hubble Space Telescope, the Rosat, Granat and Roentgen-Kvant X-ray observatories, the Compton Gamma Ray Observatory, the Hipparcos spacecraft, the Extreme Ultraviolet Explorer, and the Astro-D, Freya and Sampex satellites, and with data from the recent Stretched Rohini Scientific Satellite (SROSS-C), astronomers had powerful tools for their investigations of the universe. The planned launches of the Radioastron satellite, the Spektr-Roentgen-Gamma observatory, the Infrared Space Observatory, Spektr-UV, Relict-2 and the Scientific Applications Satellite (SAC-B) would open up further realms of the universe to detailed observation. The Subcommittee noted with satisfaction that all of those projects were open to broad international cooperation.

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10. The Subcommittee recommended that consideration of the items be continued at its next session.

XII. OTHER MATTERS

A. International Space Year - 1992

11. The Subcommittee noted the activities undertaken by the United Nations for International Space Year (ISY) as described in A/AC.105/445/Add.9, including training courses, workshops, conferences, symposia, technical advisory services and publications.

12. Noting that the participation of the United Nations in ISY had been funded by voluntary contributions, the Subcommittee expressed its appreciation to the Member States and international organizations that had made voluntary contributions for the purpose.

13. The Subcommittee noted the wide variety of national and international programmes that had been undertaken as part of ISY, including the activities being coordinated through the Space Agency Forum on International Space Year (SAFISY), COSPAR, IAF and ISPRS. It noted in particular the World Space Congress organized jointly by COSPAR and IAF, including activities organized in cooperation with the United Nations. The Subcommittee also noted that a number of major regional meetings had been organized in the context of ISY, including the European ISY Conference at Munich, Germany, the Asia-Pacific ISY Conference at Tokyo and the Asia-Pacific Workshop on Multilateral Cooperation in Space Technology and Applications at Beijing.

14. The Subcommittee noted that the international programmes initiated during ISY had made important contributions to international cooperation in space activities, particularly in the use of space technology for studying and monitoring the environment. The Subcommittee recognized the importance of continuing those cooperative activities and urged the cooperating countries to encourage other countries to participate.

15. The Subcommittee requested the Secretariat to continue to promote international cooperation in the activities initiated during ISY and to keep it informed of further developments in that area.

B. Space and Earth environment

16. The Subcommittee noted that the General Assembly, in resolution 47/67, had recommended that more attention be paid to all aspects related to the protection and the preservation of the outer space environment, especially those potentially affecting the Earth's environment. The Subcommittee also noted that the General Assembly had considered that it was essential that Member States pay more attention to the problem of space debris and had called for the continuation of national research on the question and for the development of improved technology for the monitoring of space debris.

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17. The Subcommittee noted that the General Assembly had considered that, to the extent possible, information relating to the question of space debris should be provided to the Subcommittee in order to allow it to follow the question more closely, and had requested the Secretary-General to invite Member States to provide information on their national research on space debris to the Subcommittee. The Subcommittee took note of the information that had been submitted by Member States in response to that request and that was contained in document A/AC.105/542 and Add.1 and 2. The Subcommittee heard a special presentation on the question by an expert from France, as mentioned in paragraph of the present report.

18. The Subcommittee reaffirmed the importance of reducing the generation of space debris and the need for further research concerning space debris, for the development of improved technology for monitoring space debris and for the compilation and dissemination of data on space debris. It further noted the importance of international cooperation in addressing those issues.

19. The Subcommittee noted that the General Assembly, in resolution 47/67, had considered that space debris could be an appropriate subject for in-depth discussion by the Committee on the Peaceful Uses of Outer Space in the future.

20. The Subcommittee agreed that information on national research on space debris should be provided to the Subcommittee, as in the past. This could be done through the provision of working papers, interventions in the general debate and technical presentations by specialists from Member States and international organizations.

21. The Subcommittee took note of a working paper submitted by Poland (A/AC.105/C.1/L.186) proposing that the Subcommittee request COSPAR to elaborate a report on the protection and preservation of outer space, especially concerning activities potentially affecting the Earth environment.

22. The Subcommittee requested that the Committee on the Peaceful Uses of Outer Space consider whether the question of space debris should be included on the Subcommittee's agenda for its next session.

C. Other reports

23. The Subcommittee welcomed the annual reports of WMO (A/AC.105/537 and A/AC.105/538), ESA (A/AC.105/539), INTELSAT (A/AC.105/540) and INMARSAT (A/AC.105/541) and the preliminary version of the thirty-second report of ITU on telecommunication and the peaceful uses of outer space. The Subcommittee requested those organizations to continue to report on their work.

24. The Subcommittee expressed its appreciation to COSPAR for its report on the progress of space research and to IAF for its report on highlights in space technology and applications, as contained in the publication "Highlights in Space: Progress in Space Science, Technology and Applications" (A/AC.105/522).

25. The Subcommittee noted with appreciation the participation in its session of representatives from United Nations bodies, specialized agencies and permanent observers, and found their statements and reports helpful in enabling the Subcommittee to fulfil its role as focal point for international cooperation in space.

D. Review of the future role and work of the Scientific and Technical Subcommittee

26. The Subcommittee recommended that the agenda of its thirty-first session include the following priority items:

(a) Consideration of the United Nations Programme on Space Applications and the coordination of space activities within the United Nations system;

(b) Implementation of the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82);

(c) Matters relating to remote sensing of the Earth by satellites including, inter alia, applications for developing countries;

(d) Use of nuclear power sources in outer space.

27. The Subcommittee also recommended that the agenda of the thirty-first session include the following items:

(a) Questions relating to space transportation systems and their implications for future activities in space;

(b) Examination of the physical nature and technical attributes of the geostationary orbit; examination of its utilization and applications, including, inter alia, in the field of space communications, as well as other questions relating to space communications developments, taking particular account of the needs and interests of developing countries;

(c) Matters relating to life sciences, including space medicine;

(d) Progress in national and international space activities related to the Earth environment, in particular progress in the geosphere-biosphere (global change) programme;

(e) Matters relating to planetary exploration;

(f) Matters relating to astronomy;

(g) The theme fixed for special attention at the 1994 session of the Scientific and Technical Subcommittee: "Space applications for disaster prevention, warning, mitigation and relief".

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28. The Subcommittee recommended that, regarding agenda item (g) in paragraph 27 above, COSPAR and IAF, in liaison with Member States, should be invited to arrange a symposium, with as wide a participation as possible, to be held during the first week of the Subcommittee's session, to complement discussions within the Subcommittee on the special theme.

29. With regard to the dates for the thirty-first session, the Subcommittee recommended that its session be scheduled from 22 February to 4 March 1994.
